A Survey on The Approaches Used for Detection of Defects on Leather Surfaces Using Image Processing

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Abstract— Leather is a durable and flexible material created by the tanning of animal raw hide. Leather defects are imperfections occurring in the grain surface or structure of the hide or skin, in the form of scars, abrasions etc., when neglected leads to bring down the quality and reliability of the product. Visual inspection of leather surface defects is very important in the manufacturing of leather products that requires usually high quality. This paper is a study on the approaches for localizing the defects and means to classify them.

Keywords— Contour plot; Edge detection; Filtering; Gray Level Co-occurrence Matrix (GLCM); Histogram

I. INTRODUCTION

Leather as a natural material with its kind of visual appearances—non homogeneous in color, thickness, brightness, wrinkledness, etc. The presence of defects is an important issue for adjustment of the leather production of a particular good. As a result, the existence of areas with animal skin defects, the piece of leather could also be thought-about as unusable for specific functions. Humans have a stunning capability to simply realize imperfections in spatial structures. This visual mechanism works wonderfully even if we don’t apprehend what the ideal pattern is and what kinds of defects are available. Since manual review is a slow and an effortful task, it can become a critical bottleneck within the entire production method. More importantly, higher accuracy is achieved by eliminating human error caused due to fatigue. To overcome this, the visual inspection process involved with feature illustration and extraction, as well as data perception and modeling is enforced.

II. DEFECTS IN LEATHER AND ITS TYPES

The surface defects on leather have an effect on the aesthetic look of the leather goods and also the amount of usable area. The presence of defects is a crucial issue for adjustment of the leather for production of a specific good because the existence of areas with leather defects may be considered as unusable or helpful for only particular purposes. There are various methods for analysis of leathers surface defects and classifications. Classification of the surface defects on leathers is done based on shape, size, area, depth, color, origin of the defect, etc. The various stages of leather production is given in figure.1

![Figure 1. Stages of leather production](image)

The various defects that occur at each of the processing stage is presented in Table.1.
2.1. Lumpy Ring Worm
DERMATOMYCOSIS is the technical name for lumpy ring worm. On leather, a lumpy ring worm looks like a circular formed lesions that are typically between 1 and 5 cm in diameter and typically the grain surface is also slightly raised. This fungal infection is most typically found in calves on the face and back. In adult animals it is conjointly found on the chest and legs. However the affected leather is simply removed by correcting the grain and is hid by finishing.

2.2. Flay Cuts
Flay cuts are knife marks on the flesh of hides that are caused by careless use of the knife throughout the removal of the skin from the body. Usually, the cuts penetrate well into the dermis structure wherever they lead to weak areas. In severe cases the cuts might extend through the entire thickness of the skin. Even where they do not cut all through the skin, the cuts can be invariably seen from the grain aspect since the loss of substance means that less pressure throughout the leather creating processes. Flay cuts are a significant, nonetheless an inessential contributor to the down-grading of enormous quantities of leather worldwide.

2.3. Manges
Mange is a class of skin disease caused by parasitic mites. Since mites also infect plants, birds and reptiles, the term “mange”, suggesting poor condition of the hairy coat due to the infection, is sometimes reserved only for pathological mite-infection of non-human mammals.

2.4. Warts
Warts are small, usually painless growths on the skin. Most of the time warts are harmless. They are caused by a virus.
III. TEXTURAL DEFECT DETECTION

3.1. Statistical Approach

3.1.1. Histogram

In an image processing context, the histogram of an image normally refers to a graph showing the number of pixels in an image at each different intensity value found in that image. Histogram can be used to identify changes in an image which in turn can be used to segment the defect in a particular piece of leather. According to the paper “Identification of Leather Surface Defects using Image Processing Techniques-A Study” written by Prasad Gandikota, S.Uma, C.Kumaravelu & P.Sudhakara rao [1], the gray level distribution of a typical leather surface image can be considered as a combination of three approximations of independent normal distributions. Good leather forms the background of the image and defects form the foreground of the image. This essentially means that the background pixel grey level occupies the middle part of the histogram and the defects occupy the two ends. According to Xianghua Xie [2] in the paper “A Review of Recent Advances in Surface Defect Detection using Texture analysis Techniques”, histogram statistics including range, mean, geometric mean, harmonic mean, standard deviation, variance, and median and Histogram comparison statistics, such as L1 norm, L2 norm, EMD distance, Bhattacharyya distance, Matusita distance, Divergence, Histogram intersection and Normalized correlation coefficient, can also be used as texture features. Similarly in “Leather Quality Estimation Using an Automated Machine Vision System” by Parag Kohli and Ms. Shalvi Garg [3], the histogram analysis used, gives an idea about the smoothness of the leather surface. If the histogram is a uniformly biased towards any side of the gray area, then it may be assumed that the leather surface is smooth and has no defects. However, a scattered histogram shows the coarseness of the surface. From all these basic concepts, it can be inferred that a set of threshold values obtained from histogram, can then be used to separate the defected area from the normal leather surface.

3.1.2. Co-occurrence Matrix

Spatial gray level co-occurrence matrices (GLCM) is one of the most well-known and widely used texture features extraction method. The GLCM can provide information related to the frequential distribution content of the original, spatially represented image. According to Xianghua Xie [3] and P. Mohanaiah, P. Sathyanarayana, L. GuruKumar [4] in the paper “Image Texture Feature Extraction Using GLCM Approach” it was mentioned that, the texture features like entropy, homogeneity, contrast and correlation can be obtained from GLCM. But in a comparative study by
Ozdemir et al [5] in “Comparative Evaluation of Texture Analysis Algorithms for Defect Inspection of Textile Products” it was concluded that the GLCM method showed poor performance in detecting textural defects in textile products when compared to other techniques like MRF and filtering-based methods.

3.1.3. Autocorrelation

The autocorrelation is a feature that is based on an observation that some textures are repetitive in nature. ACF measures the correlation between the image itself and the image translated with a displacement vector. Wood [6] used autocorrelation of sub images to detect textile defects in “Texture decomposition by harmonics extraction from higher order statistics.”, but according to Xianghua Xie [3], the autocorrelation function is generally considered as unsuitable for random textures with irregularly arranged textural elements. In another theory, according to Renée Panozzo Heilbronner [7] in “The Autocorrelation Function: An Image Processing Tool for Fabric Analysis”, the ACF enables: (a) a quantitative description of the fabric in general terms; (b) an efficient grain size determination; and (c) if strain is a valid interpretation of the fabric — the derivation of the finite strains in the plane of observation.

3.2. Structural Approach

The primary goals of structural approaches are firstly to obtain texture primitives or regional properties like centroid, area, major axis length, minor axis length, to name a few and secondly to model or generalize the spatial placement rules. F. Viltrotter, R. Nevatia, and K. Price [8] in the paper “Structural Analysis of Natural Textures” point to the fact that, in structural approaches, texture is characterized by texture primitives or regional properties. But J. Chen and A. Jain [9] in “A structural Approach to Identify Defects in Textured Images” present another concept for texture analysis. Based on the above theories the image measurement obtained after thresholding using histogram analysis, will be compared with the measurements of the defect-free sample in the project.

3.3. Filtering

Image filtering mainly helps to apply various effects on photos like noise removal and smoothening. Usually image filtering is done using gradient filters to extract edges, lines, isolated dots. Ade [10] in “Characterization of Texture by Eigen Filter” proposed filtering using Eigen filters whereas Coggins and Jain [11] explained using seven dynamically spaced ring filters and four wedge-shaped orientation filters, which have Gaussian cross sections, for feature extraction in “A Spatial Filtering Approach to Texture Analysis”. Elhanan Elboher and Michael Werman [12] in “Efficient and Accurate Gaussian Image Filtering Using Running Sums” consider filtering as an unambiguous image processing tool requiring fast and efficient computation. To prove the performance of Gaussian filtering methods an experiment was conducted on natural images from different scenes. In [13], the exact comparison between two filters was provided. From this paper, it can be inferred that Gaussian filters have the property of no overshoot to a step function input while minimizing the rise and fault time and that this filter is the ideal time domain filter. The images in figure .2. [14] have been taken from “The University of Auckland, New Zealand”. Gaussian filtering was used to blur the images and remove noise and unwanted detail. It was found that Gaussian was more effective in smoothening the images and it was found that it has a basis of human visual perception system. The image on the left has been reformed using Gaussian filtering and displayed in the right.
3.4. Edge Detection

The edge detection of an image is an important foundation in the field of image analysis. Edge detection is very important in digital image processing, because edge is the boundary of the target and the background. And only by determining the edge, the target and background can be differentiated. The main edge operator concentrated in this paper is the ‘Canny’ Operator. Canny operator is a method that finds the edges by isolating the noise from the image without affecting the features of the edges in the image. Canny Edge Detector aims to achieve: (a) Good detection – minimized marking of false edges. (b) Good localization - The points marked out as edge points by the operator should be as close as possible to the centre of the true edge. (c) Minimal response - Only one response to a certain edge.

M. Kalpana, Kishorebabu and Sujatha [15] in “Extraction of Edge Detection Using Digital Image Processing Techniques” state that Canny operator is a new edge detection operator and it has good performance of detecting edges over the other operators like Sobel, Perwitt or Robert., and it was found that the edges detected by canny were smooth and less noise was detected as compared to Sobel which produces messy edges and most of the important information wasn’t identified.

3.5. Contour Plot

A Contour plot is a graphical representation of a 3-dimensional surface by plotting constant z slices, called contours, on a 2-dimensional format. In “A Graph based Geometric Approach to Contour Extraction from Noisy Binary Images” by Amal Dev Parakkat, Philemon Joseph, Jiju Peethambaran, and Ramanathan Muthuganapathy [16], a method to extract the contour of geometric objects in binary digital images using the techniques of computational geometry was presented. An object point set extracted from the image is processed instead of directly dealing with pixels as in traditional contour extraction methods. The proposed algorithm works in four phases: Point extraction, Euclidean graph construction, Point linking and Contour simplification. Images contain both textured and untextured regions, so the cues of contour and texture differences are exploited simultaneously. Contours are treated in the intervening contour framework, while texture is analyzed using textons.

3.6. Visual Inspection and Marking

The paper “Automatic Visual Inspection System for Stamped Sheet Metals” by Aaron R.Rababaah and Yotan Demi-ejegi [17] present the disadvantages of human inspections compared to machines and propose an approach of an integrated software that includes image processing, segmentation, feature analysis, defect detection, qualification and classification. This method provides superiority over visual inspection and defect detection performed by humans. The paper “Artificial Vision Inspection Applied to Leather Quality Control” by F. Adamo, F. Attivissimo, G. Cavone, N. Giaquinto, A. M. L. Lanzolla [18] aims at the realization of an automatic computer vision system for leather analysis, to accurately inspect and mark the defective areas of the leather specimens before they enter the production chain.
IV. CONCLUSION

It can be noted that the defect detection on the leather surfaces is a critical process for the development of leather goods. There are significant and increasing amount of work on color texture analysis, however, limited work has so far been reported in visual inspection using color texture analysis. The majorities of the existing methods decompose the color image into separate channels and process them independently or with limited interactions. From all the paper references, it can be concluded that the segmentation and marking of the defects using machine vision is important to reduce manual errors and increase the efficiency.

REFERENCES

[14] Experiment at University of Auckland.